Semester 2 Examinations 2020 / 2021

Exam Code(s)	2BCT/2BSE
Exam(s)	2nd BSc (CS&IT), 2nd BE ESE
Module Code(s)	CT248
Module(s)	Introduction to Modelling
Paper No.	I
External Examiner(s)	Dr Jacob Howe
Internal Examiner(s)	Prof. Michael Madden
	*Prof. Jim Duggan

Instructions:

Answer any 3 questions.

Duration	2hrs (and an additional 30 mins to upload)
No. of Pages	7 (Including Cover Page)
Discipline	Computer Science
Course Co-ordinator	Dr. Des Chambers

Requirements:

Release in Exam Venue	Yes
MCQ Answersheet	No
Handout	None
Statistical/ Log Tables	None
Cambridge Tables	None
Graph Paper	None
Log Graph Paper	None
Other Materials	None
Graphic material in colour	Yes

Disclaimer that you must include at the top of your submission:	In submitting this work, I confirm that it is entirely my own. I acknowledge that I may be invited to online interview if there is any concern in relation to the integrity of my exam, and I am aware that any breach will be subject to the University's Procedures for dealing with breaches of Exam Regulations: https://www.nuigalway.ie/media/registry/exams/QA230---Procedures-for-Dealing-with-Breaches-of-Examination-Regulations.pdf

1. (a) Show how you would generate the following two vectors in MATLAB, making use of the *colon operator* and the *linspace* function. Explain each method and highlight their key difference.

```
v1 =   0    1.2500    2.5000    3.7500    5.0000

v2 =   0     1     2     3     4     5
```

[5 marks]

(b) Write a MATLAB script to calculate the frequencies of the sum of rolling two dice 100 times. The dice rolls should be simulated with <u>one call</u> to the **randi()** function. For example, the following could be an output of rolling the two dice 1000 times (first result = frequency of 2 (1+1), final result = frequency of 12 (6+6)).

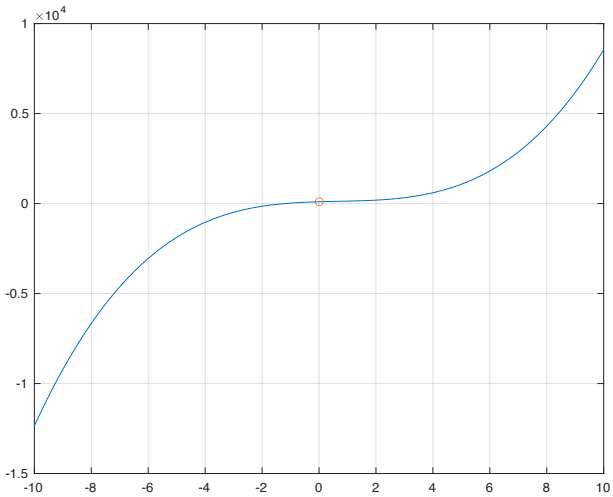
```
33    60    88   111   146   169   136   107    75    57    18
```

The MATLAB function **unique()** can be used. The results should be stored in a row vector. You can use the MATLAB **find()** function as part of the solution.

Explain how you could generate the same result each time, and the benefits of this feature. The **tabulate()** function cannot be used.

[12 marks]

(c) Generate the following plot for a cubic equation. The x value consists of 100 equally space points between -10 and + 10.



Assume a = 2, b = -2, c = 5 and d = 100

Write a command that finds the value of y when x is closest to 0 and draws this point on the graph.

Summarise the benefits of element-wise operators in MATLAB

[8 marks]

2. (a) Given that, in an M file, subfunctions are visible only to the primary function, modify this m file (called part_a.m) so that the subfunction **my_sum** can be accessed from the main workspace

```
function s = part_a(m)

  s = my_sum(m);

end

function ms = my_sum(m)

  ms = sum(m);
end
```

[8 marks]

(b) Write a function that accepts a set of exam grades, and a summary function (e.g. min, max, mean). It should then return the summary data in a new column.

If any of the data in a row is zero, then it should be assumed that the subject was not taken, and so that data point should be excluded from the calculation.

Here is sample output from the solution, where the input is the matrix m and the output is res1, which is the minimum mark received by each student.

m =	res1 =
56 78 85 54 0 0 0 0 76 65 72 87 45 96 71	56 78 85 54 0 **54** 0 0 0 76 65 **65** 72 87 45 96 71 **45**

[12 marks]

(c) What are the advantages of using an anonymous function?

For an input vector, write an anonymous function that returns the values less than the median, and the values greater than the median.

[5 marks]

3. (a) What is a table in MATLAB, and how does it differ from an array?

[4 marks]

(b) Consider the following dataset (first 5 rows shown).

```
>> mpg(1:5,:)

ans =

  5×5 table
```

manufacturer	model	class	displ	cty
"audi"	"a4"	"compact"	1.8	18
"audi"	"a4"	"compact"	1.8	21
"audi"	"a4"	"compact"	2	20
"audi"	"a4"	"compact"	2	21
"audi"	"a4"	"compact"	2.8	16

Write the following queries on this data set.

- Select all cars with a displacement greater than the mean
- Select all compact cars with city miles per gallon (cty) less than the median.

[6 marks]

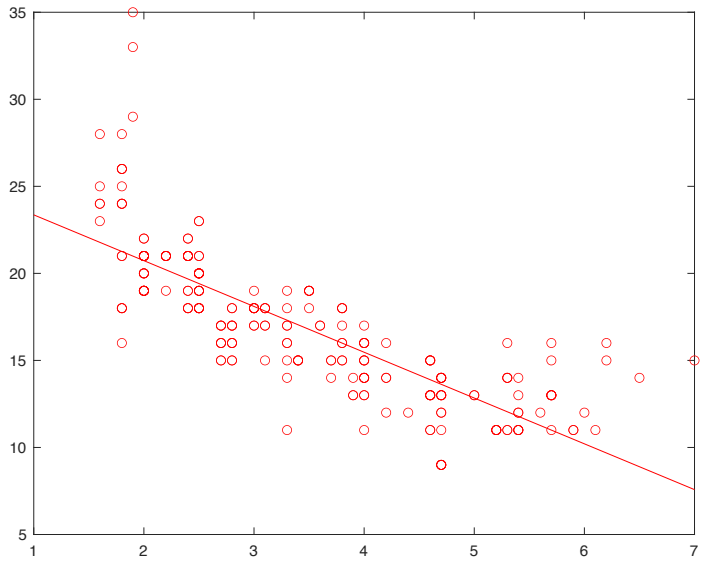
(c) Using the following example (10 records), explain (using a diagram) how the **splitapply** process works. Assume you want to get the average **cty** for toyota and volkswagen. Show the **splitapply** code as part of your solution.

```
10×5 table
```

manufacturer	model	class	displ	cty
"toyota"	"corolla"	"compact"	1.8	24
"toyota"	"corolla"	"compact"	1.8	24
"toyota"	"corolla"	"compact"	1.8	26
"toyota"	"corolla"	"compact"	1.8	28
"toyota"	"corolla"	"compact"	1.8	26
"volkswagen"	"gti"	"compact"	2	21
"volkswagen"	"gti"	"compact"	2	19
"volkswagen"	"gti"	"compact"	2	21
"volkswagen"	"gti"	"compact"	2	22
"volkswagen"	"gti"	"compact"	2.8	17

[8 marks]

(d) Based on the full **mpg** data set shown part(b), show how the following diagram can be generated. The x axis is **displ**, the y is **cty**. Make use of the function **fitlm(),** and explain what this function does. Is the relationship positive or negative?



[7 marks]

4. (a) Build an anonymous function to model the following set of differential equations that model the consumer adoption of a product and their discarding of the product. The function should accept values for the two parameters, a and b. Show how this function can be invoked from the MATLAB function **ode45().**

$$\frac{dP}{dt} = -a\,P$$

$$\frac{dA}{dt} = a\,P - b\,A$$

$$\frac{dD}{dt} = b\,A$$

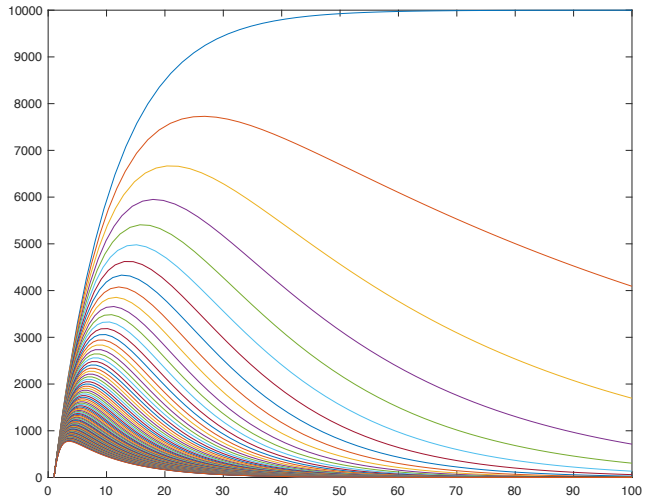
Where:

- ***P*** represents the number in the population who have not adopted the product (i.e. they are potential adopters). The rate at which people leave the population P is determined by the parameter **a**.
- ***A*** represents the number of adopters. The rate at which people adopt is determined by the parameter **a**, and the rate at which they leave the adopters is determined by the parameter **b**.
- ***D*** represents the number of people who no longer use the product.

Note, at all times, the sum of ***P***, ***A*** and ***D*** will be constant.

[15 marks]

(b) Write a script that plot 100 model runs (Adopter value) where b is between [0,1], and a is fixed at 0.10. See the following as sample output.



What is significant about the value for b, and under what circumstances will the number of adopters grow and then remain at 10000?

[10 marks]